LINQ Solutions

An Overview of Icom's Conventional IDAS™ Repeater Configurations

An Overview prepared by Icom America Inc.

Icom's IDAS™ system is a powerful and flexible digital technology utilizing IDAS radios, which have both digital and analog capabilities for future growth and backwards compatibility. The digital side of our technology, highlighted below, uses the NXDN™ protocol (Next Generation Digital Narrowband), which operates with 6.25 kHz narrowbanding, allowing for much greater frequency use options. IDAS systems can operate in either conventional repeater or trunked (NXDN Type D) modes across single site or multi-site deployments.

The elegance of Icom's IDAS systems is they all use common hardware and protocols. A few minor accessory additions and configuration options allow IDAS devices to operate in additional configurations so that your system can be designed for your unique needs.

This document describes configurations based on multi-site, conventional, digital repeated systems, referred to as IDAS LINQ Solutions. The following explanations help provide a clear understanding of what each of the LINQ configurations are, how they are different from one another, and in which operations you may want to deploy them.

Note: a key consideration in designing any radio system is creating a coverage map with appropriate overlap between repeaters to ensure that radios communicate properly. In radio communications, there may be local connection issues due to buildings, topography, or atmospheric conditions. Also a properly functioning IP network with sufficient bandwidth is essential for a LINQ system to operate.

The LINQ Solution configurations are:

LINQ™REPEAT

LINQ Repeat – two or more IDAS repeaters connected by an IP network. Each repeater transmits the traffic received directly from a subscriber radio over RF or indirectly from another repeater over IP. Every repeater has its own unique downlink and uplink frequency pair. This configuration expands the coverage you would get in a traditional repeater setup.

LINQ™REPEAT+

LINQ Repeat+ – a LINQ Repeat system with the added function of subscriber voting and signal beaconing. Every repeater has its own downlink and uplink frequency pair. A LINQ Repeat+ system allows the subscriber radios to select the strongest signal if there is more than one available.

LINQ™ VOTE

LINQ Vote – a system with one transmitting repeater (transmitter) and two or more receive-only repeaters (voting receivers). The transmitter transmits the strongest signal from the voting receivers after comparing the signal strength from each. Voting receivers all use the same uplink frequency.

LINQ™ VOTE+

LINQ Vote+ – a system with two or more transmitters and two or more voting receivers with the added function of subscriber voting and signal beaconing. Every transmitter has its own TX downlink frequency. Voting receivers all use the same uplink frequency.

LINQ™ SIMULCAST

LINQ Simulcast – a system of two or more repeaters all operating on the same downlink and uplink frequency pair. Each repeater sends its uplink traffic to the central controller that compares and selects the strongest signal. With the aid of GPS and NTP timing synchronization, the controller sends the traffic signal and timing information to each transmitter for downlink at a specific time to ensure good performance in the overlap areas. Subscriber voting is unnecessary.

LINQ Solutions

The significant feature with LINQ Solutions is that all LINQ Solutions give you expanded coverage, but not expanded capacity. LINQ Solutions are all digital conventional configurations, not trunking systems.

LINQ Components

The basic* building blocks for any LINQ solution are the following:

- IDAS Repeater
- IDAS Network Controller Board
- IP Repeater Link Card
- IP Network connectivity
- IDAS subscriber radios

*As with any properly designed RF system, following the fundamentals of grounding, antenna separation, and frequency isolation using filtering are mandatory for effective performance.

Details of LINQ Configurations

Traditional Stand-alone Repeater

To understand and contrast LINQ operation with standard repeater operation, the following describes a traditional repeater configuration.

Repeaters are used to expand the radio coverage in an area beyond the range of radio to radio call. When several repeaters operate in a region, they provide even greater radio coverage throughout that region. As commonly deployed, repeaters operate independently as stand-alone repeaters. This deployment of repeaters has its place in the radio world and often is used when there is little overlap in repeater coverage area or when different groups use different repeaters.

However, there are several drawbacks with using stand-alone repeaters throughout a region for a group of users working in that area. The three main drawbacks are:

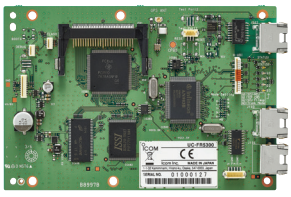
1) an inability to communicate with other radios outside a local repeater coverage area
2) forgetting to change the channel when moving out of one coverage area into another
3) using a repeater that is further away with a weaker signal and poor reception when another with a stronger signal is nearby

CF-FR5000

IP network upgrade software

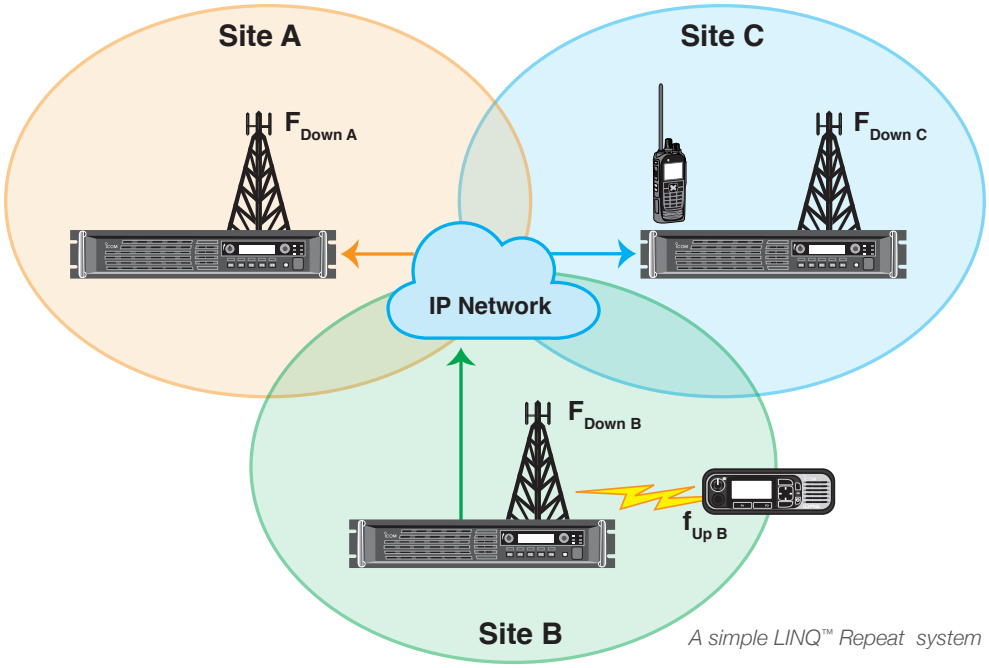
LINQ Repeat

LINQ Repeat connects a group of stand-alone repeaters via an IP network. With the addition of the UC-FR5300 Network Controller board and CF-FR5000 multisite card in each repeater, up to 16 repeaters can be interconnected to create an RF multicast system. Each transmitter uses a different downlink frequency. LINQ Repeat allows a subscriber radio to have its transmission retransmitted by each interconnected repeater even if its signal only reaches one of the repeaters! With the use of IP networks, the repeaters can be anywhere with access to a reliable IP network. This extends the range of coverage beyond the RF footprint of one repeater to as many as 16 repeaters. The repeaters can be located geographically close to one another to give near 100% coverage in a region or at 16 'hotspots' located far apart (worldwide).



UC-FR5300

Trunking/Network controller board

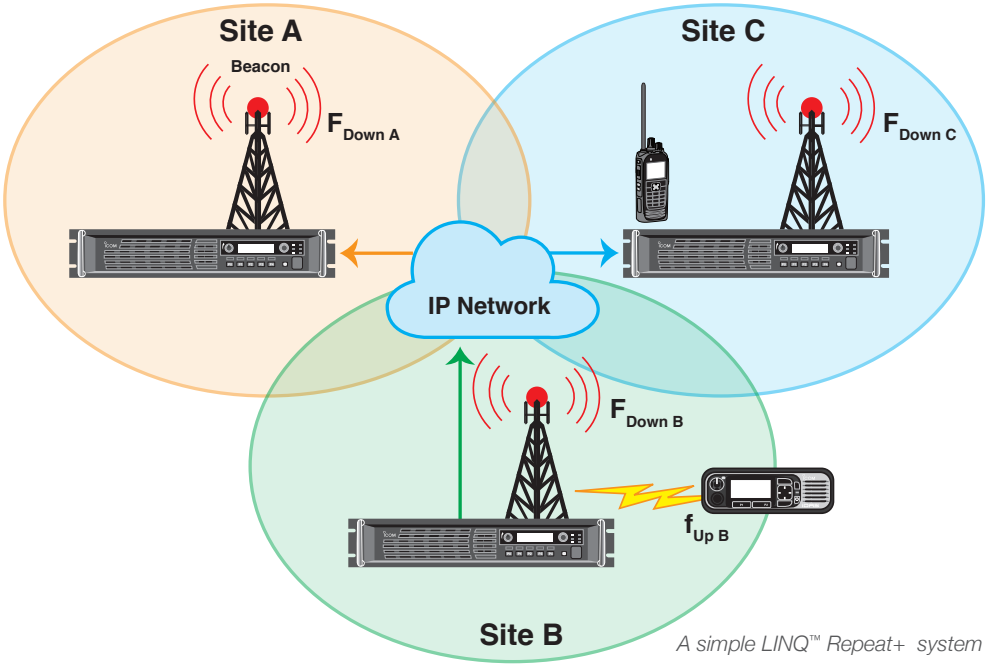


A simple LINQ™ Repeat system

For example, a group of subscribers who operate routinely within a well-established area such as a campus or a county, would find a LINQ Repeat configuration where repeaters slightly overlap RF coverage areas. Another example may be that of several buildings located in different parts of a city, each having a hotspot repeater linked together. Both examples would allow all subscribers to talk among themselves regardless of which repeater they were accessing.

LINQ Repeat+

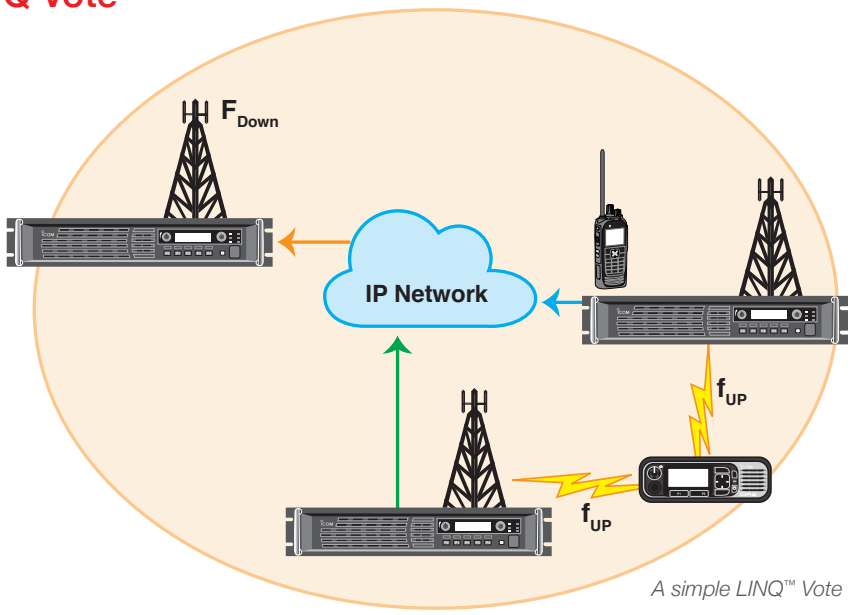
In a LINQ Repeat configuration, the subscriber would have to switch channels as they move between repeaters. If they forget to change channels, they lose the ability to talk to other subscribers. LINQ Repeat+ addresses this by having the subscriber radios programmed to listen to a set of downlink frequencies transmitted by the repeaters and automatically switching to the channel of the repeater with the strongest downlink signal, a function called vote scan. There are times when the system usage is low and there are no signals for the subscriber to hear and assess. When that happens, the subscriber stays on the last channel and doesn't switch. To account for that scenario, LINQ Repeat+ also includes a beaconing downlink signal sent by all repeaters periodically. This beacon ensures the subscriber has a signal on which to use to make the switch.



A simple LINQ™ Repeat+ system

A LINQ Repeat/Repeat+ system transmits any signal received and does not consider the signal strength for downlink.

LINQ Vote



A simple LINQ™ Vote system

LINQ Vote is targeted for a different use case. A LINQ Vote system has only one transmitting repeater and two or more receive-only 'repeaters', or

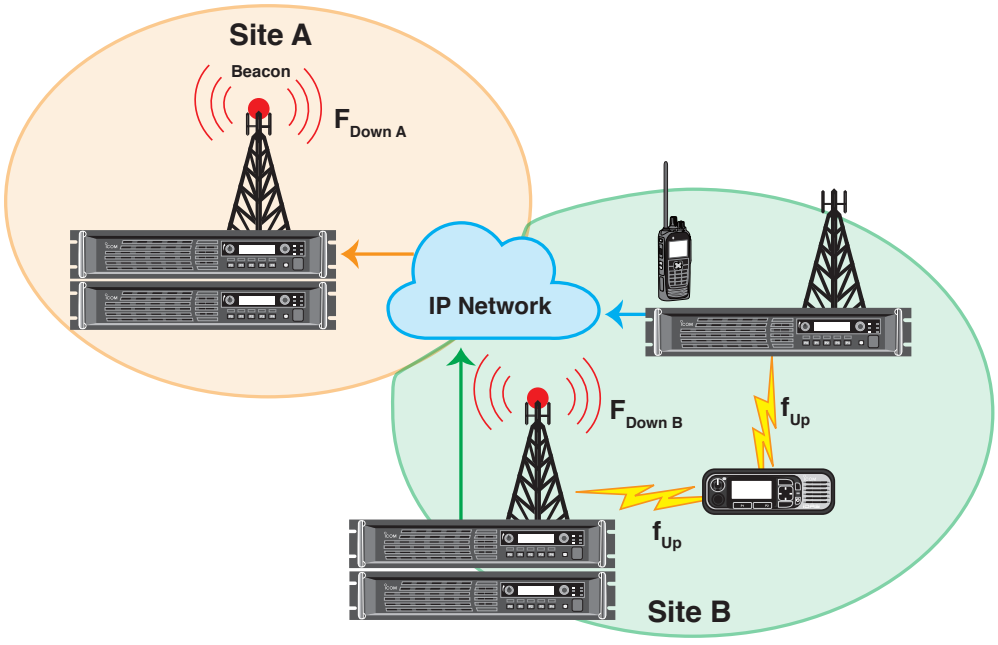
receivers, connected by a reliable IP network. A LINQ Vote deployment is used when the transmitter downlink is strong enough to reach all the subscribers in the area but the subscriber uplink is too weak to reach back to the repeater. This is common when the subscriber radios are portables, which have limited transmit power. Adding a LINQ Vote receiver where there is weak uplink allows the subscriber signal to be relayed, via IP, back to the transmitter for downlink. All receivers share the same uplink frequency so the subscriber only has to have one uplink/downlink frequency pair programmed into it.

It is highly likely that several receivers may hear the uplink from a subscriber with one signal being stronger than the others. So, built into the LINQ Vote transmitter is the function of a voting comparator which inspects and selects the strongest of all the signals received for downlink transmission.

Parking garages or areas shadowed by hills or buildings would benefit from LINQ Vote.

LINQ Vote+

LINQ Vote+ expands LINQ Vote by using multiple transmitters when all subscribers are not in range of a single transmitter. This creates an RF multicast system, with each transmitter using different downlink frequencies. LINQ Vote+ provides much wider coverage than the single transmitter in LINQ Vote. LINQ Vote+ can also include the vote scan function in the subscriber unit and transmitter beaconing so seamless channel changes occur as in LINQ Repeat+.



A simple LINQ™ Vote+ system

With either LINQ Vote or LINQ Vote+, when initiating a call, the subscriber will uplink with a common RX frequency shared by all the receivers on the network. One or several receivers may hear the subscriber uplink signal. The receivers next transport the signals as IP packets over the network to all the transmitters in the system. All transmitters have the voting comparator function configured so the strongest signal is then retransmitted in the downlink.

LINQ Vote+ are used in wide area systems with overlapping coverage areas, tunnels, high-rises, for example.

The individual repeaters for LINQ Repeat, LINQ Repeat+, LINQ Vote, LINQ Vote+ solutions use the same hardware. Only the amount and configurations of the hardware vary by solution.

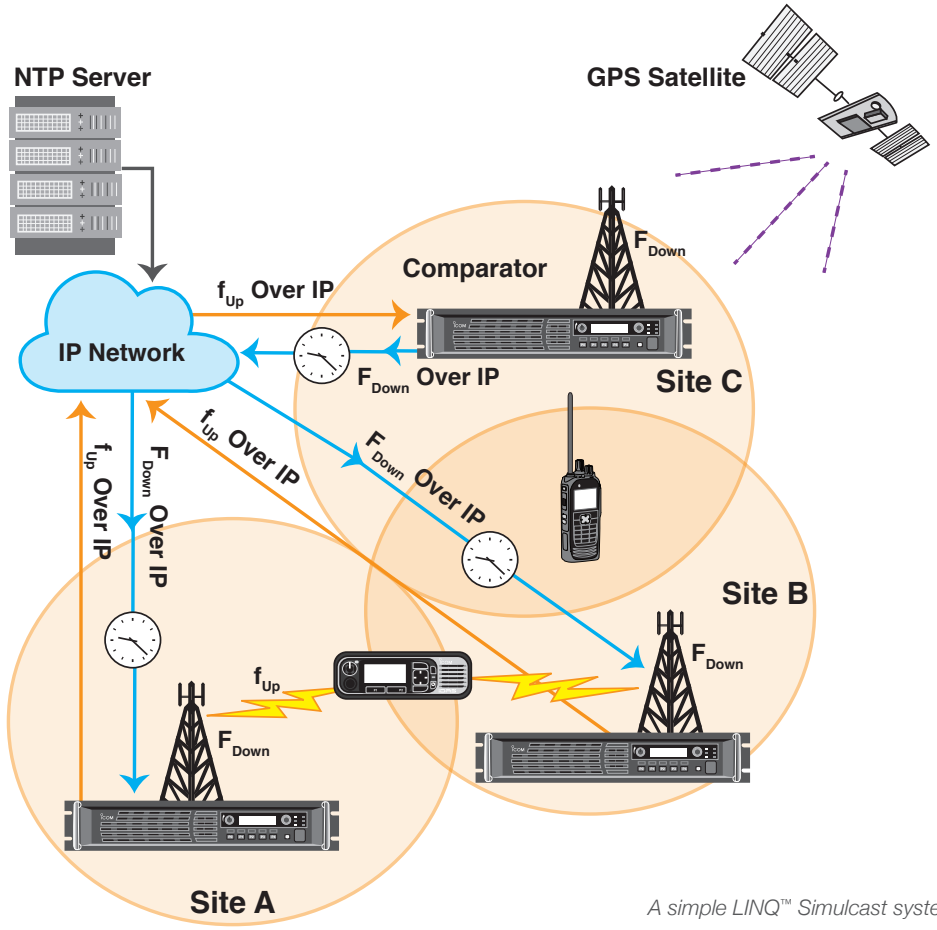
LINQ Simulcast

The most recent addition to the LINQ Solution set is LINQ Simulcast. Whereas LINQ Repeat, LINQ Repeat+, LINQ Vote, and LINQ Vote+ are similar in many aspects, LINQ Simulcast differs in the uplink/downlink characteristics. As a simulcast solution, LINQ Simulcast uses the same pairs of uplink/downlink frequencies across all repeaters. This has several benefits.

1) Fewer frequencies are required from the FCC. With IDAS operating at 6.25 kHz channel spacing, available frequencies throughout a coverage area are more easily obtained than 12.5 kHz channel licenses.
2) No receive-only units are utilized, yet the system is still able to compare and retransmit the strongest uplink signal it receives from the other repeaters.
3) Subscriber units do not need to vote scan in order to be on the proper channel for the repeater of which they are in range. This frees up the capability to have the subscriber scan other channels, such as simplex or other repeater system channels.

Simulcast solutions require extra diligence in their design. It is expected that repeater coverage areas will overlap in a simulcast system, so how that overlap zone is designed is important for good performance. Engineering studies to minimize the overlap are essential. Selecting antenna patterns and power output help in that regard. Once the overlap areas are established, the timing of the downlink transmission between all repeaters is critical. IDAS LINQ Simulcast use of GNSS (GPS), NTP, and PING protocols to establish the proper timing for each repeater to synchronize downlink transmission. One repeater in the system is the main repeater (controller) which compares the signal strength from each of the other repeaters to select the strongest for downlink across

the system. The controller also sends the transmit time to each repeater for a synchronized downlink transmission. Icom's IDAS subscriber radios are able to handle downlink signals that arrive up to 80µsec apart.



A simple LINQ™ Simulcast system

System Enhancement Accessories

Dispatch Options. Often, the scale of a LINQ Solutions system makes a centralized dispatch desirable. Icom has a range of dispatch products that work with LINQ Solutions. The Icom RC-FS10 Remote Communicator IP networked software package works well for basic, radio-like functions from a computer. A paddle microphone and an external speaker allow simple dispatching operation. A configurable customized screen provides for group calling, individual unit calling, short data messaging and a full array of signaling and calling features.

Third party dispatch console systems can operate with a LINQ Solution system. Remotatec, Avtec and Omnitronics offer a complete, integrated product while other console systems have been used successfully as well.

RC-FS10

Virtual Radio/Dispatch Software for an IDAS™ Conventional IP Network System

VE-PG4

RoIP Gateway

Radio System Gateway. Radio systems frequently need to be integrated into a larger communication system. Icom's VE-PG4 radio gateway provided a means to interconnect SIP telephony, LTE radios, satellite radios, aviation radios, trunked radio systems, analog radios, WLAN radios, intercoms, and I/O devices. Including a VE-PG4 gateway can transform a LINQ Solution into an amazingly flexible and robust system.

Conclusion

The Icom LINQ System offers multiple solutions to common issues with traditional conventional repeater systems. The great strength of LINQ is its ability to be scaled to the individual needs of customers who desire more reliable coverage. Experts at Icom America are ready to work with customers to design a system that meets their requirements. This support is critical to ensuring that their system performs as expected. It can be easily upgraded with hardware/software for future use.

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About Icom

Icom started in Japan in 1964, and quickly became a leader in amateur radio products. In the following years Icom has grown to provide radio equipment for marine, land mobile, and avionics applications. It has become a leader in the design and manufacturing of radio equipment that reaches across the spectrum from simple radios to sophisticated IP-based systems. Icom America is responsible for representing Icom products within the entire Western Hemisphere, as well to U.S. Territories in the Pacific. For more information, visit our website or click here to request support.

Glossary

- **Beaconing.** A signal that is sent by a repeater that enables subscriber radios to receive a transmission for the purposes of subscriber voting.
- **Channel.** A specific frequency (or frequency pair) on which a radio transmits and receives RF signals.
- **Conventional.** The most basic repeater radio system. A fixed channel, non-trunked, repeater system that receives signals on one frequency and transmits on another.
- **Downlink.** The signal that a repeater transmits to a subscriber radio.
- **Mobile (radio).** A radio designed to be mounted in an automobile.
- **Multicast.** A system of transmitters transmitting the same signal using different downlink frequencies. Note: Downlink frequencies may be reused if transmitters have non-overlapping coverage areas.
- **NXDN™.** A digital protocol that uses 6.25 kHz channel spacing to enable more efficient use of RF frequency spectrum. NXDN was developed jointly by Icom and JVCKenwood.
- **Portable (radio).** A handheld radio powered with a battery. Power output typically 4-6 watts.
- **Receiver.** Receivers simply accept radio frequency signals.
- **Repeater.** A radio with two different frequencies that simultaneously receives on one and transmits on another to extend the range of an RF signal.
- **RF Hotspot.** A geographical location with a strong radio signal.
- **RSSI.** Receive Signal Strength Indicator. A key metric that radios use to evaluate the strength of a radio signal.
- **Scan.** A radio's ability to look at multiple frequencies and stop at active frequencies.
- **Simplex.** Radios programmed with the same frequency for both receiving and transmitting.
- **Simulcast.** A multi-site repeater system, using the same frequency set for all sites, where a central controller tells the various transmitters when to transmit so the subscribers receive the transmissions "in-phase".
- **Subscriber.** A radio user radio that is part of a commercial radio system. Also, frequently used as shorthand for either a portable or mobile radio.
- **Subscriber voting.** A form of voting where the subscriber radio evaluates the RSSI signal and transmits the strongest one, also called vote scan.

- **System voting.** A form of voting performed by the comparator. Devices in the LINQ system analyze the signals from the subscriber radios and transmits the strongest signal.
- **Talkgroup.** A dedicated group of users on a common channel that is separated from other users using applicable signaling “gates” as found in the IDAS digital protocol.
- **Transceiver.** A radio which has both a receive and transmit capability.
- **Transmitter.** A transmitter is any device that sends a radio-frequency signal.
- **Trunked.** A repeater system that uses a control channel on each site to automatically assign frequency channels to groups of user radios. This controller directs traffic between channels and directs the subscriber units as to which channel to immediately turn to. This gives the system the ability to receive multiple signals at the same time and repeat to other repeater sites.
- **Uplink.** The signal that a subscriber radio transmits to a repeater.

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